Economic Botany and Ethnobotany in Al-Andalus (Iberian Peninsula: Tenth-Fifteenth Centuries), an Unknown Heritage of Mankind

Author(s): J. Esteban Hernández Bermejo and Expiración García Sánchez

Source: *Economic Botany*, Vol. 52, No. 1 (Jan. - Mar., 1998), pp. 15-26
Published by: Springer on behalf of New York Botanical Garden Press
Stable URL: http://www.jstor.org/stable/4256021

ECONOMIC BOTANY AND ETHNOBOTANY IN AL-ANDALUS (IBERIAN PENINSULA: TENTH–FIFTEENTH CENTURIES), AN UNKNOWN HERITAGE OF MANKIND[1]

J. ESTEBAN HERNÁNDEZ BERMEJO, AND EXPIRACIÓN GARCÍA SÁNCHEZ

Hernández Bermejo, J.Esteban *(Jardín Botánico de Córdoba and Departamento de Ciencias y Recursos Agrícolas y Forestales, Universidad de Córdoba, Apdo. 3048 Córdoba, Spain), and* **Expiración García Sánchez** *(Escuela de Estudios Arabes, C.S.I.C., Cuesta del Chapiz, 22, Granada, Spain).* ECONOMIC BOTANY AND ETHNOBOTANY IN AL-ANDALUS (IBERIAN PENINSULA: TENTH–FIFTEENTH CENTURIES), AN UNKNOWN HERITAGE OF MANKIND. *Economic Botany 52(1)15–26. 1998.* *The Hispano-Arabic culture in the Iberian Middle Ages is a major chapter in the history of the use and knowledge of plants. The Andalusi agronomists, botanists and physicians assimilated their heritage of Iberian, Hispano-Roman, and Hispano-Visigothic cultures with North-African and Eastern influences. They developed a profound knowledge of the plant world and managed a high diversity of species. A part of this ethnobotanical and agronomic heritage was transmitted not only to the local cultures and generations that followed, but also to peoples on the other side of the Atlantic Ocean by the Spanish colonists in the New World. This paper presents a study of the principal works of the so-called Andalusi Agronomic School (10th–15th centuries) and their agronomist authors: Arib ben Said, Ibn Wafid, Ibn Hayyay, Abu l-Jayr, Ibn Bassal, al-Tignari, Ibn al-Awwam and Ibn Luyun. We also raise questions about Andalusi ethnobotany, the introduction of Oriental species in the Iberian Peninsula and the prospects for ethnobotanical research through the philological study of Hispano-Arabic writings.*

La Botánica Economica y la Etnobotánica en Al-Andalus (Península Ibérica, Siglos Diez-Quince: un Patrimonio Desconocido de Humanidad). *La cultura hispanoárabe que se desarrolla durante el Medioevo Ibérico incluye un capítulo destacado relativo al uso y conocimiento de las plantas. Los agrónomos, botánicos y médicos andalusies asimilan el patrimonio de sus culturas predecesoras (ibérica, hispanorromana, hispanovisigoda) y junto a las influencias orientales y norteafricanas de su época, alcanzan un gran conocimiento del mundo vegetal manejando una elevada diversidad de especies. Una parte de este patrimonio etnobotánico y agronómico será transmitido más allá de su ámbito temporal y geográfico, alcanzando incluso el otro lado del Atlántico, a través de los colonos españoles en el Nuevo Mundo. Este trabajo nos introduce en el estudio de los principales autores y obras de la llamada Escuela Agronómica Andalusí (siglos 10–15). Entre los agrónomos estudiados se encuentran, Arib ben Said, Ibn Wafid, Ibn Hayyay, Abu l-Jayr, Ibn Bassal, al-Tignari, Ibn al-Awwam e Ibn Luyun. Se plantean algunas cuestiones sobre la existencia de una etnobotánica andalusí, sobre la introducción de especies orientales en la Península Ibérica, y sobre las perspectivas de la investigación etnobotánica a través del estudio filológico de las obras y autores hispanoárabes.*

Key Words: al-Andalus; Andalusi agronomic school.

The crucial role played by the Iberian Peninsula in the introduction and exchange of species between the European and American continents is an unquestionable fact that has been object of numerous works and will still be a major subject for future research.The years immediately prior to 1992 were especially significant for conducting investigations on the exchange of species and cultures between American and European peoples. Most contributions have analyzed the impressions of the first Spanish explorers, colonists, farmers, chroniclers, physicians and naturalists after their arrival in America and the species transported by them (Crosby 1991; Dawson 1960; del Río Moreno 1991; Estrella 1986; Watson 1983). In contrast, we could point to the depth of knowledge of the transport of American species into Europe from eighteenth century onward (García Paris 1991) and what took place

[1] Received 16 April 1996; accepted 25 July 1997.

in this regard in the sixteenth and seventeenth centuries (Hernández Bermejo and Lora González 1994; Hernández Bermejo and León, eds. 1995; Lora González 1994).

The role and influence of Spain in the transport of species from the Old World and the transfer of its traditional techniques, habits, and culture, cannot be understood without knowledge of the origin and history of the Mediterranean, European, and Iberian cultures and species. These, together with other Asian and African influences, took form over several millennia and gave rise to the agriculturally based cultures and landscapes and to the diversity of useful plant species that define the ethnobotanical and agricultural framework of Spain in the fifteenth century.

Over 135 million years, the Iberian Peninsula has been linked intermittently two major land masses before the appearance of humans. Later during the Meso- and Neolithic Ages, it was a gateway between North Africa and the southern Europe as well as the terminus of the long transport processes from the East to the West along the Mediterranean coasts and islands. During the millennium prior to the Christianity, the Phoenician, Greek, Carthaginian and Roman colonizations took place north of the Iberian Peninsula. After the first century, the Roman Empire promoted trade from Asia Minor, Africa and the Mediterranean basin. After the fall of the Roman Empire in the fourth century, the Visigothic Kingdom was established in the Iberian Peninsula and was influenced by the Byzantine Empire, especially during the sixth and seventh centuries. With this flow of empire over the centuries came the transfer from the East to West of crop, medicinal and aromatic plants.

In order to understand the legacy transmitted by the Iberian cultures and peoples to America it is important to begin in the eighth century and to focus on the tenth century and later. We are referring to the Hispano-Arabic Period, known by the historians as the Andalusi Period. It is convenient to clarify that al-Andalus was not only the southern region that it is known today as Andalusia, but the whole of the Iberian territory under Moslem domination. This historical period begins with the invasion of Tarik and the defeat of the Visigothic King Rodrigo in the battle of the Lake of La Janda in the year 711 and ends with the conquest of Granada by the Catholic Monarchs in 1492. From a cultural viewpoint, however, the roots and culmination of this period are not so precise and, in any case, its splendor does not take such a long time to develop. Therefore from our point of view, we consider the Andalusian Period to cover the tenth to fifteenth centuries.

From an ethnobotanical point of view, the consequences of this period can be observed through very different contributions: species of agricultural interest introduced from Asia to Africa, other plants previously known but now grown as main crops, new agricultural techniques (Glick 1988), management and knowledge of countless medicinal plants and promotion of the scientific disciplines such as natural history, botany, pharmacology and medicine. The results were contained in many works and treatises, some of which have survived to our time. Moreover this knowledge has been transmitted since then through oral tradition. The so-called Reconquest of the Christian Kingdom interrupted the formal transmission of this heritage, by destroying documents and "forgetting" authors. But it would not eliminate the local culture that would conserve techniques, habits and plant varieties through generations. Much of this knowledge was carried to the American continent by the first Spanish explorers, colonists, and farmers. The rescue of this Andalusi ethnobotanical heritage is of great interest in order to recover neglected species and forgotten knowledge. And it can also be used in economic botany and ethnobotanical studies in America as a documentary source for understanding the origin and nature of a great part of the Old World's contributions to the New World.

We must recognize the existence of certain deficiencies in this source of information. Most of the original manuscripts were lost and ill-treated from the fifteenth century to the Enlightenment (eighteenth century). The documents were written originally in Arabic but only in a few cases were translated into other languages. Furthermore, there was poor communication between the fields of philology and arabism and those of botany, agronomy, pharmacology and ethnobotany. Our paper attempts to overcome this problem. Finally the difficulties for the translation and identification of the texts are noteworthy, especially as regards the agricultural species and terms used (Issa 1926). We have pointed out these problems and outlined the multidisciplinary method to solve them (Hernán-

dez Bermejo 1987; 1991). Some Arabists have confused Asian crops introduced into Europe with American species (for example, *Musa paradisiaca* with *Opuntia ficus indica,* or *Aloe vera* with *Agave americana*). More mistakes appear when the original translation from Arabic into Latin, or a modern language, is translated again into another modern language. These preliminary misidentifications have led scholars to underestimate the possibilities of the scientific analysis of these texts.

Biodiversity and Iberian Ethnobotanical Heritage Before the Andalusi Period

The biodiversity of the economic flora of the Iberian Peninsula began with the autochthonous species:

Forest Trees of Edible Fruit

Several species of the Mediterranean forest were used because of their fruits and a domestication process was initiated (still not finished today). Species of the genus *Quercus* must be pointed out (evergreen oak *Q. ilex,* cork oak, *Q. suber,* gall oak *Q. faginea*). Others, in a wild state in certain regions of the Iberian Peninsula could have been subject to very ancient transport, as it is the case of *Corylus avellana* (hazelnut), *Castanea sativa* (chestnut) and *Pinus pinea* (pine).

Fruit Trees

There were many different tree species of the Rosaceae family with edible fruits as *Crataegus monogyna* (hawthorn), *Pyrus* spp. (wild pear), *Sorbus aucuparia, S. aria* (rowan), *Prunus* spp. (*P. avium, P. mahaleb, P. spinosa*). Other edible fruits were those of *Myrtus communis* and *Arbutus unedo,* as well as those of southern species that could be easily introduced into the southern Iberian Peninsula: *Prunus avium* (sweet cherry) and *Malus domestica* (apple).

Cereals

Some wild species of *Hordeum* (barley) and *Avena* (oat) were originally used.

Legumes

Different species of the genera *Lathyrus* (vetchlings), *Vicia* (vetches) and *Lupinus* (wild lupines).

Vegetables

Several species of Apiaceae, Asteraceae, Boraginaceae, Chenopodiaceae, Cruciferae and Liliaceae could be used as wild or cultivated vegetables because of their leaf, fruit or root. For example, *Apium* (celery), *Daucus* (carrot), *Anchusa* and *Symphytum* (bugloss), *Lactuca* (wild lettuce), *Cichorium* (chicory), *Chenopodium* (goose-foot), *Rumex* (dock), several cardoons such as *Scolymus* spp. *Silybum marianum* and even *Cynara cardunculus.* Also *Asparagus* spp. (asparagus), *Beta vulgaris* (beets), *Silene* spp. (campion), *Diplotaxis* spp. and *Brassica* spp., *Raphanus sativus* (radish), *Lepidium* spp. (peppergrass), *Nasturtium* spp. (watercress), *Atriplex* spp. (orach) and *Allium* spp. (wild garlic and onions). Other sources of carbohydrates: Flours were obtained from the seeds of plants such as *Polygonum* spp. and *Chenopodium* spp. or from fern roots (*Pteridium aquilinum*).

Spices, Aromatic Species

The first Iberian settlers and farmers found a very diverse flora in spices such as: *Capparis* spp. (caper bush), *Laurus nobilis* (laurel), *Sinapis* spp. and *Brassica nigra* (mustard), *Foeniculum vulgare* (fennel), *Ruta graveolens* (rue), several Lamiaceae as *Rosmarinus officinalis* (rosemary) and *Origanum vulgare* (marjoram), and many species of other genera such as *Mentha* (mint), *Satureja* (savory), *Thymus* (thyme) and *Lavandula* spp. (lavender).

Joining the autochthonous species, economic plants from Central Europe, the Balkan and Italic Peninsulas, Africa, Asia Minor and even from Eastern Asia had arrived over several millennia in the western Mediterranean basin prior to the Arabic period. The chronology of this gradual enrichment can be established through the works of naturalists, physicians, agronomists and some Greek and Roman writers (Estrabo, Pliny, Dioscorides, Virgil) and even better through some Hispano-Roman and Hispano-Visigothic authors (Columella, Isidorus of Seville). This allochthonous component in the Iberian Peninsula added over the Neolithic to the Spanish-Roman Period includes:

Fruit Trees and Forest Species of Edible Fruits

Olea europaea (olive) and *Vitis vinifera* (grape), perhaps completely allochthonous from the eastern Mediterranean, became the main

woody crops of the Iberian Peninsula. Other allochthonous species, such as *Ceratonia siliqua* (carob), *Celtis australis* (hackberry), *Ficus carica* (fig) and *Juglans regia* (walnut) acquired a wide distribution, and even became feral. The use of species such as *Pinus pinea* (pine) and *Castanea sativa* (chestnut) was consolidated and intensified. Other species introduced were *Pyrus communis* (pear), different oriental species of *Prunus* like *P. domestica* (plum), *P. armeniaca* (apricot), *P. persica* (peach) and *P. dulcis* (almond), *Phoenix datylifera* (date palm), *Cydonia oblonga* (quince), *Mespilus germanica* (medlar), *Ziziphus lotus* (jujube) and *Punica granatum* (pomegranate).

Cereals

Wheat (*Triticum* spp.), barley (*Hordeum vulgare*) and rye (*Secale cereale*) together with sorghum, millets and broomcorn (*Sorghum vulgare, Panicum miliaceum, Setaria* spp.) became the main source of carbohydrates.

Legumes

Important legumes had already arrived from Western Asia such as: *Cicer arietinum* (chick pea), *Vicia faba* (broad bean), *Lens culinaris* (lentil), *Pisum sativum* (pea) and *Vigna sinensis* (cowpea), as well as other species of *Lathyrus* and *Vicia.*

Vegetables

Species such as *Brassica napus* (rape), *B. oleracea* (cabbage, kale), *Lactuca sativa* (lettuce), *Apium graveolens* (celery), *Smyrnium olosatrum* (alexanders), *Allium cepa* (onion), *A. sativum* (garlic), *Lagenaria siceraria* (bottlegourd) were cultivated.

Spices, Aromatic Species

The rich autochthonous component was also enriched by other Oriental and European species such as *Coriandrum sativum* (coriander), *Petroselinum crispum* (parsley), *Carum carvi* (caraway), *Cominum ciminum* (cumin), *Pimpinella anisum* (anise), *Carthamus tinctorius* (safflower) and *Anethum graveolens* (dill, anethum).

This catalogue of indigenous and introduced useful species of Visigothic Hispania prior to Arabic colonization was lengthy and diverse.

The Andalusi Agronomic School: Origin, Influences, Principal Authors, Evolution

Agriculture in the Iberian Peninsula reached a somewhat productive level before its splendid achievements during the Roman colonization. Afterwards it entered into a phase of stagnation and even regression during the Visigothic period.

A new and deeper agricultural development in the Iberian Peninsula began with the arrival of the Arabs in the eighth century the Andalusi scientists started to make original contributions in the tenth century. In addition to the new tendency to become independent from the eastern culture and science, a series of elements and circumstances converged in al-Andalus that would be the embryo of the so-called "Andalusi Agronomic School" It would reach zenith in the eleventh and twelfth centuries (García Sánchez 1992). The principal agronomist-writers of the Andalusi Agronomic School were:

Tenth Century

Arib ben Said: Historian, agronomist, physician and veterinarian from Cordova. *Calendario Agrícola* (translation by Pellat 1961)

Andalusi anonymous: Unknown author from Cordova. *Tratado Andalusí de Agricultura* (translation by López López 1990)

Eleventh Century

Ibn Wafid: Physician and agronomist from Toledo. *Compendio de Agricultura* (translation by Millas Vallicrosa 1943)

Ibn Hayyay: From Seville. Lo que basta saber sobre Agricultura (translation by Carabaza 1988; 1994; interpreted by Bolens 1981) *Plantas en al-Andalus en el siglo XI* (Carabaza 1994)

Ibn Bassal: Agronomist from Toledo. *Tratado de Agricultura* (translation by Millas Vallicrosa and Aziman 1955. Interpreted by García Sánchez and Hernández Bermejo, 1995)

Abu al-Jayr: From Seville. *Tratado de Agricultura* (translation by Carabaza 1994)

al-Tignari: From Granada. *Esplendor del jardín y recreo de las mentes* (translation and interpretation by García Sánchez 1987, 1988)

Twelfth Century

Ibn al-Awwam: Agronomist from Seville. (Abu Zacarías) *Tratado de Agricultura* (translation

by Banqueri 1802; interpretation by Hernández Bermejo and García Sánchez 1988)

FOURTEENTH CENTURY

Ibn Luyun: From Granada. *Tratado de Agricultura* (translation by Eguaras 1975)

The Andalusi Agronomic School took the first steps in Cordova during the Caliphate Period within the group of physicians, chemists and botanists associated with the monarchs Abd al-Rahman III (912–961) and his son al-Hakam II (961–976). One of most influential factors for the development of pharmacology and botany and, consequently, of agronomy was Dioscorides' *Materia Medica* (Dietrich 1988), a copy of which the Byzantine Emperor Constantino VII Porfirogeneta sent to the Cordovan Caliph Abd al-Rahman III.

Nevertheless the most decisive event for the appearance of the Andalusi Agronomic School was the edition of the *Calendario de Córdoba* by Arib ben Said. This work of the tenth century is of vital importance for the study of botany and agriculture in Spain during the Moslem domination (Dozy ed. 1961). Many of the plant species introduced by the Arabs into the Iberian Peninsula are documented in this work for the first time. Also mentioned is the cultivation of many other species that were already acclimatized in the territory and whose use and cultivation were encouraged by them.

There is another text of the end of the tenth century, *Tratado Andalusí de Agricultura* (anonymous), that is probably the first written agronomic treatise in al-Andalus (López López 1990).

The climax of this agronomic school that led to the "Andalusi agricultural revolution" took place in a very specific historical moment: the decentralization period instituted by the Moorish Kingdoms after the breaking up of the Caliphate of Cordova (eleventh century). Moreover other factors were added: 1) A comprehensive translation program of documents on the Greek-Roman, Byzantine and mainly Mesopotamian agronomic heritage (eighth-tenth centuries) carried out in the Moslem East; 2) The advances in medical, pharmacological and botanical studies initiated in Cordova in ninth-tenth centuries; and 3) The urban development that, when facing the problem of food supply in the Hispano-Arabic cities, spontaneously encouraged research projects towards the promotion and improvement of the agricultural sector (Lagardére 1993). In addition, the new Arabic settlers took advantage of the richness of the Iberian soil and of the important Hispano-Roman agricultural tradition (El-Faïz 1996).

In the eleventh century, the "School" founded in Cordova was transferred first to Toledo and then to Seville, and a close relationship with Granada was maintained. Despite the subsequent cultural and political decline, the *Poema Agrícola* by Ibn Luyun was written in the second half of the fourteenth century.

Few biographical data of these authors are known. This condition, together with the miscellaneous and summarized state of the Andalusi agricultural manuscripts, has made it quite difficult to study their works (Ullmann 1972). We have only limited information of those who were well known in other scientific fields. For example Ibn Wafid was a physician and chemist from Toledo and whose teachings were followed by another Andalusi agronomist, Ibn Bassal.

Ibn Bassal stands out above all the Andalusi authors for his personality. His knowledge was mainly based on his personal experience. After the reconquest of the Moorish Kingdom of Toledo by the Christians (1085), Ibn Bassal (like the rest of the intellectuals of the city) moved to Seville which then became the headquarters of the "school."

Abu al-Jayr, from Seville, appears by that time. Little is known about his theoretical-practical work, except some indirect information through other authors. Perhaps the best representative of the theoretical approach is Ibn Hayyay, about whom no biographical data are available. In contrast to his contemporary Ibn Bassal (1073), he compiled an impressive mosaic of quotations from previous authors, some of which are compared with his own experience. Studies of his work (Bolens 1981) show the influence of the Latin agronomic tradition, especially of Columella. This interpretation is considered suggestive but remains controversial.

Al-Tignari was the last author of the eleventh century, although his work came out in the first decade of the twelfth century. He was born on a farm near Granada. He was a physician, as well as a good writer and an excellent poet. After having travelled through North Africa and the Near East, he went back to al-Andalus, and lived in Granada and Seville. In Seville he

joined the group of agronomists and botanists associated with Ibn Bassal. Only half of his original manuscript is preserved but his work, in which theory and experience in fields like medicine, botany and linguistics are united, is one of the most ordered and systematic of the Andalusi agronomic treatises.

The encyclopedia on rural economy by Ibn al-Awwam came to light one century later. It was the only reference for Spanish-Moslem agronomy available for a long time and, paradoxically, little is known about the author except that he lived in Seville in the twelfth-thirteenth centuries. One of the merits of his agricultural treatise is that it includes an enormous number of citations from Andalusi and oriental texts. Therefore, besides being a compilation of the previous agronomic theories, it can help to identify some original texts (mainly by Spanish-Moslem authors) which are not known in their complete form. This book is one of the few intact works and presents all the zootechnic and agricultural knowledge of that time. It contains traditional information as well as that obtained through his own experience.

The last known work of the Andalusi agriculture is a didactic poem by Ibn Luyun (1349) from Almeria. It contains agricultural information, mainly obtained from the treatises by Ibn Bassal and al-Tignari. It is one of the few agricultural works that, along with the one by Ibn al-Awwam, is complete, which is unusual for Andalusi agronomic literature (Hernández Bermejo and García Sánchez 1988).

All of these authors acquired their knowledge from different sources: the first and most important source was the Greek-Byzantine eastern tradition; second, the Latin tradition, that undoubtedly existed, although the details of its transmission is not so well known as that of the Greek; and finally the assimilation of autochthonous knowledge comprising the Latin-Mozarabic heritage. In addition to these sources we must consider the knowledge gathered and transmitted in the *Agricultura Nabatea,* the first great Arabic work on agriculture, which represented the Mesopotamian tradition at the beginning of the tenth century.

Evaluation of the Andalusi Ethnobotanical Heritage: the Agricultural Treatises

The Andalusi treatises, especially the complete ones, follow the pattern of those of the classic Roman and Greeks, and Eastern cultures. Initial chapters focus on lands, waters, fertilizers, followed by plant crop issues and finish with zootechnology and veterinary practices. Agricultural calendars are usually included in these treatises along with astronomical and meteorological calendars and references to magic, local traditions, and experiences of the farmers. They conclude with practices of farm management, control of crop pests and diseases, and recommendations on the physical and moral factors to be considered when selecting the workers and persons in charge of the farm operation.

Some of these treatises, such as the *Libro de Agricultura* by Ibn Bassal, are eminently practical. They were written by agricultural technicians and were of great utility for the farmers of that time. The original and very interesting *Agricultural Calendar* by Arib ben Said describes not only the landscape but also the Mediterranean agricultural cycle of one thousand years ago. Other encyclopedic works cite authors, describe different experiences, and lead to rigorous scientific conclusions. An outstanding work of this type is the book by Ibn al Awwam.

The interest of some of these treatises in topics that today are characteristic of the concern for sustainable or ecological agriculture is noteworthy. It is remarkable to encounter, for example, the obsession for recycling nutrients, the appropriate use of manure, the preventive aspects of pest and disease management, the control techniques based on natural repellents, and treatments (that today are considered as phytohormonal) to facilitate vegetative propagation and rooting.

Another valuable insight gained when interpreting the agricultural structure and landscape described in these works is that they reflect the management of a very high biological diversity. The number of species mentioned in almost all these treatises is not only greater than that of previous cultures, but it is also greater than that of other contemporary and subsequent agricultural systems and surveys (Herrera 1513) of the surrounding Christian Kingdoms. Agriculture in the Christian Kingdoms was organized to provide a diet based on the trilogy of meat-wheat-wine and was a less varied and drier agriculture. In contrast with this system, the water management in irrigated lands, the establishment of orchards in valleys and on river banks and the cultivation of dry land, tree crops (almonds, carobs,

oaks, figs, jujubes, pistachios and wine grapes) made the Hispano-Arabic agriculture and way of living and food much more complex. Diversity of the agricultural landscape was accompanied by the knowledge and management of a large number of cultivars. Some authors describe in detail their morphological differences and uses.

Part of this diversity includes crops that have been lost or neglected in modern agriculture, such as *Silybum marianum, Cichorium intybus, Eruca sativa* and *Smyrnium olosatrum.* Some others disappeared in the Iberian agriculture but are still cultivated in other regions of the world, *Zizyphus lotus, Pistacia vera, Portulaca oleracea, Vigna sinensis* . Finally some are nearly extinct in our region of reference but were introduced into America, such as *Cichorium intybus, Vigna sinensis, Coriandrum sativum* and *Lathyrus vulgaris.*

An example of this type is the work by Ibn Bassal from Toledo. He is far from being a very exhaustive author and his work is one of the less extensive ones because it focused on practical matters rather than theoretical aspects. According to our recent review and analysis (Table 1), the species cited by this author could represent the basic agricultural flora in the eleventh century. Nevertheless, we should be aware that this catalogue is not a complete work, but only a summary. The lack of significant information concerning cereals and other dry-land crops in this work may only be the result of the incompleteness of what is available to us.

Another aspect of great interest is the gradual arrival of Oriental species. It is possible to recreate one of the most interesting chapters of the dispersion process of agricultural species by specifying the chronology of their introduction, the effective establishment of their cultivation and the evolution of their different uses and varieties. We have already dealt with these subjects by comparing the incremental references to Asian and African species by Spanish-Roman, Spanish-Visigothic authors and by the principal Andalusi agronomists in the tenth to fourteenth centuries (Hernández Bermejo 1991). Table 2 shows some of the species introduced during this period.

At this stage of our study we find it advisable to make only a preliminary interpretation of these lists. In addition to the methodological difficulties aforementioned, there are also some doubts concerning whether the species were only known and consumed or were also cultivated. For instance, some of the plants whose introduction into the Iberian Peninsula has been traditionally attributed to the Arabs, were already cited by Isidorus of Seville in the seventh century (ed. 1982). This is the case of the sugar cane (*Saccharum officinarum*), citron tree (*Citrus medica*), mulberry (*Morus* spp.), saffron (*Crocus sativus*), some species of cotton (*Gossypium* spp.), pepper (*Piper nigrum*), ginger (*Zingiber officinale*) and many species of cinnamon and camphor (*Cinnamomum* spp.).

These doubts still remain among the Hispano-Arabic authors. Probably some of the species mentioned by them were never cultivated in the Western Mediterranean because of their tropical character. This may be the case of pepper (*Piper nigrum*), indigo (*Indigofera indica*), cinnamon (*Cinnamomum zeylanicum*), or snowbell (*Styrax officinale*). Others, such as henna (*Lawsonia inermis*) or tree cotton (*Gossypium arboreum*) not present in contemporary Iberian agriculture, were established crops in that time. Other species were common crops that have been neglected or even totally forgotten today e.g., *Pistacia vera, Zizyphus lotus, Vigna sinensis, Linum usitatissimum, Cannabis sativa, Lepidium sativum, Eruca sativa, Portulaca oleracea, Cichorium intybus, Silybum marianum, Myrtus communis* and *Urginea maritima.* A comprehensive research program on this subject would surely lead to the recovery of certain crops.

ANDALUSI ETHNOBOTANY

THE ORAL TRADITION

In the written records of Andalus there are many evidences of the importance of direct experience and of the oral transmission of knowledge. Thus, Ibn al-Awwam (Banqueri 1802, reedited 1888), the Andalusi agronomist who compiled the greatest number of bibliographical sources, after mentioning them, ends by saying: "No sentence is expressed in my Work that I have not previously experienced many times." In other paragraphs we can find phrases such as: "It is said (by the farmers) that it is convenient . . . " On the other hand, authors like Ibn Bassal based their teachings on their own experience or on their contemporaries experience as farmers.

If an ethnobotanical tradition is understood to emphasize the oral transmission of plant knowl-

TABLE 1. SPECIES IDENTIFIED IN THE *LIBRO DE AGRICULTURA* BY IBN BASSAL IN THE ELEVENTH CENTURY (FROM GARCÍA SÁNCHEZ AND HERNÁNDEZ BERMEJO 1995).

Acacia abysinica Benth., babul acacia
Adenocarpus spp.
Adiantum capillus-veneris L., maiden hair fern
Alcea rosea L., holly hock
Allium cepa L., onion
Allium porrum L., leek
Allium sativum L., garlic
Althaea cannabina L., mallow
Althaea officinalis L., marsh mallow
Amaranthus blitum L., amaranth
Amaranthus graecizans L., amaranth
Anchusa azurea Miller, bugloss
Anthemis sp., chamomile
Arbutus unedo L., strawberry tree
Artemisia absinthium L., wormwood
Asparagus acutifolius L., (wild) asparagus
Asparagus albus L., asparagus
Asparagus officinalis L., common asparagus
Atriplex hortensis L., orach
Balsamodendron spp., balsam tree
Beta vulgaris L. var. *cicla* L., beet
Boswellia sp., incense tree, frankincense
Brassica napus L., rape
Brassica nigra (L.) Koch, black mustard
Brassica oleracea var. *acephala.*, DC., kale
Brassica oleracea var. *botritys,* broccoli
Brassica oleracea L. var. *capitata* L., cabbage
Calystegia sepium (L.) R.Br., bindweed
Capparis ovata L., bush
Capparis spinosa L., caper bush
Carthamus sp. (*C. arborescens*?, *C. lanatus*?), safflower
Carthamus tinctorius L., safflower
Carum carvi L., caraway
Cassia fistula L., golden-shower
Castanea sativa Miller, chestnut
Celtis australis L., hackberry
Ceratonia siliqua L., carob tree
Chamaemelum sp., chamomile
Chamomilla recutita (L.) Ranschert, chamomile
Chelidonium majus L., celandine
Cicer arietinum L., chick pea
Cichorium intybus L., common chicory
Citrullus colocynthis (L.) Schrader, bitter apple, colocynth
Citrullus vulgaris Schrader, water melon
Citrus aurantium L., orange
Citrus limon (L.) Burm. fil., lemon
Citrus medica L., citron
Commiphora abyssinica (Berg.) Engl., myrrh
Convolvulus arvensis L., field bindweed
Convolvulus althaeoides L., bindweed

TABLE 1. CONTINUED.

Convolvolus tricolor L., dwarf morning-glory
Coriandrum sativum L., coriander
Corylus avellana L., hazelnut
Crocus sativus L., saffron
Cuminum ocyminum L., cumin
Cucumis flexuosus L., snake melon
Cucumis melo L., melon
Cucumis sativus L., cucumber
Cupressus sempervirens L., cypress
Cydonia oblonga Miller, common quince
Cymbopogon schoenanthus (L.) Spr., (oil) grass
Cynara cardunculus L., cardoon
Cynara scolymus L., artichoke
Cyperus rotundus L., coco grass, nut grass
Cyperus esculentus L., nut sedge
Cytisus spp., dyer's broom
Daucus carota L., carrot
Dipsacus fullonum L., wild teasel
Dolichos lablab L., hyacinth bean
Dolichos melanophtalmos DC., asparagus bean
Elaeagnus angustifolia L., oleaster
Erysimum cheiri (L.) Crantz., wall-flower
Ficus carica L., fig tree
Ficus sycomorus L., sycamore
Fraxinus angustifolia Vahl., ash
Fraxinus excelsior L., European ash
Fraxinus ornus L., flowering ash
Genista spp., broom
Gossypium arboreum L., tree cotton
Gossypium herbaceum L., levant cotton
Hordeum vulgare L., barley
Hyphaene thebiaca Mart., gingerbread palm
Jasminum officinale L., jasmine
Juglans regia L., walnut
Juncus sp., rush
Lactuca sativa L., lettuce
Lagenaria siceraria (Mol.) Stand., bottle gourd
Lathyrus sp., wild peas
Laurus nobilis L., laurel
Lawsonia inermis L., henna
Lens culinaris Medic., lentil
Lepidium sp., pepper grass
Ligustrum vulgare L., common privet
Lilium candidum L., madonna lily
Linus usitatissimum L., flax
Lupinus albus L., white lupine
Lycium spp., box thorn
Lygeum spartum L., feather grass, rush
Malus domestica Borkh., common apple
Matricaria sp., matricary
Matthiola incana (L.) R.Br., stock
Melia acederach L., paradise tree
Melilotus officinalis (L.) Pall., yellow sweet clover
Melissa officinalis L., common balm
Mentha suaveolens Ehrh., apple mint

TABLE 1. CONTINUED.

Morus alba L., white mulberry
Morus nigra L., black mulberry
Myrtus communis L., myrtle
Narcissus spp., daffodil
Narcissus papyraceus Ker-Gawler, daffodil
Narcissus pseudonarcissus L., daffodil
Narcissus tazetta L., daffodil
Nasturtium vulgare R. Brown., watercress
Nerium oleander L., oleander
Nigella sativa L., black cumin
Ocymum basilicum L., common basil
Olea europaea L., olive tree
Onopordum sp., thistle
Origanum majorana L., sweet marjoram
Oryza sativa L., rice
Panicum spp., panic grass
Panicum miliaceum L., broomcorn
Papaver sp. (probl. *P. rhoeas* L.), poppy
Papaver somniferum L., opium poppy
Pastinaca sativa L., parsnip
Pennisetum spp., millet
Phoenix dactylifera L., date palm
Phragmites communis Trin., reed
Pimpinella anisum L., common anise
Pinus spp., pine tree
Piper nigrum L., black pepper
Pistacia terebinthus L., cyprus-turpentine
Pistacia vera L., pistachio tree
Pisum sativum L., garden pea
Populus alba L., white poplar
Populus nigra L., black poplar
Portulaca oleracea L., purslane
Prunus armeniaca L., apricot tree
Prunus avium L., sweet cherry tree
Prunus domestica L., plum tree
Prunus dulcis (Miller) D.A. Webb, almond tree
Prunus mahaleb L., mahaleb
Prunus persica (L.) Batsch, peach tree
Punica granatum L., pomegranate tree
Pyrus communis L., pear tree
Quercus rotundifolia Lam., oak tree
Raphanus sativus L., radish
Retama sphaerocarpa (L.) Boiss., broom
Rosa spp., rose
Rubia tinctorum L., madder
Rubus spp., bramble
Rumex spp., dock
Ruta spp., rue
Salix spp., willow
Salix alba L., white willow
Salix babylonica L., weeping willow
Salix purpurea L., basket willow
Scirpus holoschoenus L., soft rush
Sesamum indicum L., sesame
Setaria italica (L.) Beauvois, foxtail millet

TABLE 1. CONTINUED.

Sinapis alba L., white mustard
Solanum melongena L., egg-plant, aubergine
Sorghum bicolor (L.) Moench, sorghum
Spinacia oleracea L., spinach
Stipa tenacissima L., esparto
Styrax benzoin Dryand., snowbell
Styrax officinale L., snowbell
Terminalia sp., myrobalan
Thymus mastichina (L.) L., thyme
Triticum spp., wheat
Ulmus spp., elm
Ulmus minor Miller, elm
Urginea maritima (L.) Baker, sea onion
Verbascum spp., mullein
Vicia sp., vetch
Vicia ervilia (L.) Willd., bitter vetch
Vicia faba L., broad bean
Vigna unguiculata (L.) Walpers., cowpea
Viola tricolor L., European wild pansy
Vitis vinifera L., wine grape
Ziziphus lotus (L.) Lam., jujube

TABLE 2. DATES OF FIRST REFERENCES TO SOME PRINCIPAL AGRICULTURAL SPECIES INTRODUCED INTO THE IBERIAN PENINSULA FROM SEVENTH TO FOURTEENTH CENTURIES.

Species	Century
Cannabis sativa L.	10th
Carthamus tinctorius L.	11th
Citrus aurantiifolia (Christm. et Panz.) Sw.	14th
Citrus aurantium L.	11th
Citrus grandis (L.) Osbeck	11th
Citrus limon (L.) Burn. fil.	10th
Citrus medica L.	7th (before?)*
Crocus sativus L.	10th (7th?)*
Glycyrrhiza glabra L.	7th
Gossypium arboreum L.	13th
Gossypium herbaceum L.	10th
Indigofera tinctoria Lam.	11th
Lawsonia inermis L.	10th
Musa spp. L.	10th (7th?)
Oryza sativa L.	10th
Saccharum officinarum L.	10th (7th?)
Solanum melongena L.	10th
Sorghum spp.	11th
Spinacia oleracea L.	11th

* The question marks indicate a possible previous introduction (because they are mentioned by Isidorus of Seville in his Etymologies).

edge, then the writings of the Andalusi agronomists attest clearly to the existence of such a tradition. It is probable that a very significant component of the popular knowledge that was transmitted from Spain to America in the sixteenth and seventeenth centuries and that is still conserved on both continents mainly come from that ancient heritage gathered, processed and augmented during the history of al-Andalus.

Plants and the Andalusi Cosmic Vision

Did the Andalusi culture have tree species that played a role similar to these in the cosmic vision of many indigenous cultures? Did any sacred tree or species exist around which a cosmology for the Hispano-Arabic civilization could be established? Indeed it is risky to give specific answers, but we can remember that the date palm (*Phoenix datylifera*) is the tree that best defines the Arabic civilization. The role of this species and especially its fruits as food for the nomadic and sedentary peoples from Western Africa to the Orient is reflected by the rich terminology conserved in the Arabic language: each morphological element of the palm is named by one or more terms. Each stage of the maturation and germination of dates has specific names (Löw 1967). This tree is frequently cited in the Koran as a gift of Providence to mankind because it also provides other highly valued resources for food, pottery and industry. Palm groves have always been centers of sedentism and civilization in the desert. The cover and shade of the palm create favorable conditions for the development of animal and plant life (Fillion 1884; Viré 1993).

Up to what point was this obsession and dependence taken to the territories of al-Andalus? Although the palm did not play the same significant role as in the deserts of Northern Africa and the Near East, its presence in poetry and in the Andalusi gardens has been an unquestionable fact since the Cordovan Caliphate in the tenth century.

Other trees also played a major role in the Hispano-Arabic landscape and culture: the autochthonous cork and evergreen oaks (*Quercus suber, Q. ilex, Q. rotundifolia*) dominated the countryside, fed men and cattle, marked the different seasons, heated ovens and hearths, and produced material for farming implements, tools and furnishings. The olive tree (*Olea europea*), fig (*Ficus carica*), pomegranate (*Punica granatum*), hackberry (*Celtis australis*) and mulberries (*Morus* spp.) provided food, handcrafts, habits and ways of living. In short, all these species were characteristic of the cultures and ecosystems at that time.

Medicinal Plants

One of the most influential accomplishments of the Andalusi Agronomic School was the translation from the Greek into Arabic of the *Treatise on Medical Issues* by Dioscorides in Cordova during the tenth century. Most of these agronomists were also physicians (Ibn Waffid, al-Tignari) and Dioscorides work became an essential instrument for them.

To a certain extent the Andalusi agricultural treatises were influenced by the humoral medical theory by Galen and Hippocrates which was applied to the classification of soils, water, fertilizers and plants. References to the properties of the species studied are frequent: the quince is considered to be antidepressive; lentil "fattens the blood," in relation to its high content of iron; oil from safflower seeds has medical applications (not specified); aphrodisiac properties can be found in turnip, wild leek and chamomile oil; the colocynth is used as a laxative; chestnuts have vermifuge properties, like chickpeas (which also facilitate menstruation) and the juice from the leaves of the apricot tree; the carob bean is a diuretic; the leaves and the skin of the lemon are used as antidotes against certain poisons, as is anise.

Not only the curative properties are mentioned by the agronomists. Some plants also prevent organic irregularities derived from the frequent ingestion of others (for example, sleep difficulties and visual problems caused by the broad bean). They even describe methods by which they introduce (generally through incisions) certain drugs into the plants in order to promote properties of the introduced substances in the treated plant.

Obviously, the dietetic and therapeutic qualities of the wild and cultivated species described by the Andalusi agronomists must be understood within the context of medieval medicine. Some concepts found in these references may be completely forgotten today. After careful and critical reading, we might discover the existence of current uses of previously unknown origin or rediscover certain applications that might be reintroduced today.

Knowledge and Management of Wild Species

Despite the great interest in crops, the wild species are not forgotten, either for being exploited directly from their natural populations or for their properties and applications. Thus amongst the cultivated species, fruits of different species such as *Rhamnus* spp., *Rubus* spp., *Arbutus unedo, Myrtus communis, Crataegus monogyna, Sorbus* spp. are collected as well as the wood of *Salix* spp. and *Populus* spp.. Amongst the wild species, oleander (*Nerium oleander*) is used against nits, lice and other parasites on the hair; myrtle (*Myrtus communis*) is collected because of its application for cosmetics (to blacken and strengthen the hair); sea onion (*Urginea maritima*) is used against mice; cords are made from the leaves of the date palm; plants such as rocket (*Eruca sativa*), peppergrass (*Lepidium* sp.) or alexanders (*Smyrnium olosatrum*) have stimulant properties, etc. The catalogue is huge and still to be compiled.

Conclusions: Perspectives of the Ethnobotanical and Philological Research in the Hispano-Arabic Authors

Much research is still needed concerning the agriculture of al-Andalus, the exploitation and conservation techniques, the cultivated species as well as those directly used from the wild, among other topics. This is not only a cultural heritage from the past, but also crucial information to understand the history and evolution of the human/plant relationship and to recover useful species and knowledge for mankind.

The interest in this subject has been renewed after having been ignored by historians and Arabists for a long time. As a consequence, a variety of projects has been initiated. The first phase (already in progress) is philological because these texts require rigorous revision and translation. The identification and interpretation of the names of the plants cited in the texts are especially difficult because, in addition to the strictly philological problems, inconsistencies and mistakes between scientific and common names may also appear. These concerns led to the formation in the late 1980s of a multidisciplinary team formed by Arabists, agronomists and botanists. This team continues to carry out a series of projects, integrated in the national and regional research programs, that will lead to a better knowledge of the agriculture in al-Andalus.

Without any doubt, the Hispano-Arabic agriculture of the eleventh-thirteenth centuries was the most important of the Muslim world. It compiled the previous agricultural knowledge and introduced many innovations, leaving its mark on the agricultural practices of the Christian world. All that Hispano-Arabic agricultural tradition crossed the Atlantic Ocean and was introduced in the New World by the first European colonists, where it mixed with the indigenous knowledge and with other influences imported from other continents.

Acknowledgments

We would like to express our gratitude to Mr. José Luis Camacho for the English version of the manuscript and to Dr. Robert Bye for his observations on the text and revision of the English version.

Literature Cited

Banqueri, J. A. [translation 1802, re-ed. 1888]. Ibn al-Awwam: Kitab al-filaha. (Libro de Agricultura). Imprenta Real, Madrid.

Bolens, L. 1981. Agronomes andalous du Moyen Age, Droz, Genéve-Paris.

Carabaza Bravo, J. 1988. Ahmad b. Muhammad b. Hayyay: Lo que basta saber sobre agricultura, 2 vols. Universidad de Granada, Granada.

———. 1991. Tratado de agricultura de Abu l-Jayr, Instituto de Cooperación con el Mundo Arabe, Madrid.

———. 1994. Plantas en al-Andalus en el siglo XI. Monografías del Jardín Botánico de Córdoba, Vol. 1.

Crosby, A. W. 1991. El intercambio transoceánico. Consecuencias biológicas y culturales a partir de 1492. Instituto de Investigaciones Históricas. Serie Historia General, Universidad Nacional Autónoma de México. México, D.F.

Dawson, G. 1960. Los alimentos vegetales que América dió al mundo. Serie Técnica y Didáctica n° 8. Facultad de Ciencias Naturales y Museo de la Universidad Nacional de La Plata. La Plata.

Dietrich, A. 1988. (ed.) Dioscorides Triumphans, 2 vols. Göttingen.

Dozy (ed., translation by Pellat.) 1961. Le Calendrier de Cordoue de l'année 961. E.J. Brill. Leiden.

Eguaras, J. 1975. Ibn-Luyun: Tratado de Agricultura. Patronato de la Alhambra y Generalife. Granada.

El-Faiz, M. 1996. L'apport des traités agronomiques hispano-arabes à l'histoire économique d'al-Andalus. Pages 403–433 *in* E. García Sánchez, ed., Ciencias de la Naturaleza en al-Andalus, C.S.I.C., Granada.

Estrella, E. 1986. El pan de América. Etnohistoria de

los alimentos aborígenes en el Ecuador. Consejo Superior de Investigaciones Científicas. Centro de Estudios. Madrid.

Fillion, M. Cl. 1884. Atlas histoire naturelle de la Bible, Lyon-Paris.

García Paris, J. 1991. Intercambio y difusión de plantas de consumo entre el Nuevo y el Viejo Mundo. Servicio de Extensión Agraria. Ministerio de Agricultura, Pesca y Alimentación. Madrid.

———. 1987–88. El tratado agrícola del granadino al-Tignari. Quaderni di Studi Arabi. Vol. V–VI:278–291.

Garcia Sanchez, E. 1988. Al-Tignari y su lugar de origen. Al-Qantara, Vol. 9:1–11.

Garcia Sanchez, E. 1992. Agriculture in Muslim Spain. Pages 987–999 *in* Salma Khadra Jayyusi, ed., The Legacy of Muslim Spain, Handbuch der Orientalistik. I. Abteilung, Leiden-Köln.

Garcia Sanchez, E., and J. E. Hernández Bermejo. 1995. Estudio premilinar al Libro de Agricultura de Ibn Bassal. Pages 7–66 *in* Ibn Bassal, El Legado Andalusí. Granada.

Glick, Th. F. 1988. Irrigation and Society in Medieval Valencia, trad. cast., Regadío y sociedad en la Valencia medieval, Valencia.

Hernández Bermejo, J. E. 1987. Aproximación al estudio de las especies botánicas originariamente existentes en los Jardines de Madinat al Zahara. Cuadernos Madinat al Zahara. Vol. I:61–80.

———. 1991. Botanical Foundations for the Restoration of Spanish Arabic Gardens: Study of the Plant Species Used and their Introduction during the Andalusi Period. Pages 153–164 *in* Tjon Sie Fat and De Jong eds The Authentic Garden, Leiden.

———, **and E. García Sánchez.** 1988. Estudio preliminar al Libro de Agricultura de Ibn al-Awwan. Pages 11–46 *in* Ibn Al-Awwan. Ministerio de Agricultura. Madrid.

———, **and J. León, eds.** 1995. Neglected Crops: 1492 from a different perspective. Food and Agriculture Organization of the United Nations. Roma.

———, **and A. Lora González.** 1995. El transporte recíproco entre América y Andalucía de especies agrícolas de interés alimentario. Instituto de Investigaciones Históricas. UNAM, México.

Herrera, A. de. 1513 [1981]. Agricultura General. Ed. facsímil. Ministerio de Agricultura. Madrid.

Isidoro de Sevilla siglo VII, ed. 1982. Etimologías. Texto en latín. Traducción y revisión por J. Oroz Reta y M. Marcos Casquero. Madrid, BAC.

Issa, A. 1926. Dictionnaire des plantes en latin, français, anglais et arabe, Le Caire.

Lagardère V. 1993. Campagnes et paysans d'al-Andalus (VIIIe-XVes.), Paris.

López López, A. 1990. Un tratado agrícola andalusí. C.S.I.C. Granada.

Lora González, A. 1994. El papel de España en la introducción de especies vegetales de interés económico procedentes de América. Tesis Doctoral. Universidad de Córdoba. Córdoba

Löw, I. 1967. Die Flora der Juden, 4 vols. Hildesheim (reimp. 1ª ed., Wien-Leipzig.

Millas Vallicrosa. 1943. La traducción castellana del Tratado de Agricultura de Ibn Wafid. Al Andalus 8:281–332.

Millas Vallicrosa y Aziman. 1955. Ibn Bassal: Libro de Agricultura. Instituto Muley El-Hassan. Tetuán.

Río Moreno, J. A. del. 1991. Los inicios de la agricultura europea en el nuevo Mundo (1492–1542). Asaja, Sevilla.

Ullmann, M. 1972. Die Natur-und Geheimwissenschaftem im Islam, Leiden-Köln.

Viré, F. s. v. 1993. "Nakhl" *in* Encyclopédie de Islam, Vol. 7, nouvelle édit. Leiden-New York-Paris.

Watson, A. M. 1983. Agricultural Innovation in the Early Islamic world. The Diffusion of Crops and Farming Techniques, Cambridge University Press, Cambridge.